"!Specs for Bandbeeston Design"

```
M=300*convert(lbm,kg)                                  "Mass of BB in Kg"
A_f=40.5*convert(in,m)*(7.5*12)*convert(in,m)          "Cross-sectional area"
V=5.833*convert(ft/s,m/s)                              "Velocity"
rho=1.2[kg/m^3]                                        "Air Density"
Cd=0.41                                                "Drag coefficient (same as formula car)"
z=.25*convert(in,m)                                    "Sinkage Depth"
d=12*convert(in,m)                                     "Diameter of rigid wheel"
Cr=(z/d)^(1/2)                                         "Rolling coefficient"
a=18.25*convert(ft/s^2,m/s^2)                          "Acceleration"
g=9.81[m/s^2]                                          "Gravity"
theta=arcsin(0/100)                                    "Angle of incline"
r=6*convert(in,m)                                      "radius of wheel"
RPM=113[1/min]                                         "RPM at 2.5 mph"
Torque=93.75[lbf-in]                                   "Stall Torque of motor"
Capacity=7[A-hr]                                       "Amp hours of battery"
R_I=0.025[ohms]                                        "Internal resistance of battery"
R_m=0.089[ohms]                                        "Resistance of motor"
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"Force of Drag"

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F_d=.5*Cd*rho*A_f*V^2
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"Rolling Resistance Force"

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F_r=Cr*M*g*cos(theta)
```

"Force of Gravity"

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F_g=M*g*sin(theta)
```

"Force at the wheel"

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F_w=F_d+F_r+F_g
```

"Power needed"

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Power=F_w*V
```

"Amps continous"

```
Amps=Power/24[V]
```

"Torque needed during Acceleration"

```
T=g*M*(r/g)*a
T2=T*convert(N-m,lbf-ft)
T3=T2*convert(lbf-ft,lbf-in)
```

"Power needed during Acceleration"

```
P_a*convert(Hp,ft*lbf/s)=2*pi*RPM/60[s/min]*T2
Amps_acc=P_a*convert(Hp,w)/24[V]
```

"Amps needed for 1 hour of operation"

```
Amps_acc*1[hr]=Amphour
```

"Torque at half RPM delivered by motor"

```
Torque_output=(Torque/2)*(8.3*3)
Torque_output_lbf=Torque_output*convert(lbf-in,lbf-ft)
```

"Amperage available from battery"

Time_acc=(Capacity/Amps_acc)*convert(hr,min)
Time_cont=(Capacity/Amps)*convert(hr,min)

"Max amperage of battery"

Max_a=12[V]/(R_l+R_m)

"Average operating time"

Avg=(Time_acc+Time_cont)*.5

"Continuous amperage needed by each motor"

Cont_amp=Amps/(3^(1/2))

"Max amperage needed for each motor"

Acc_amp=Amps_acc/(3^(1/2))

"Time continuous per motor"

Adj_time_acc=(Capacity/Acc_amp)*convert(hr,min)
Adj_time_cont=(Capacity/Cont_amp)*convert(hr,min)

"Adjusted average time"

Adj_avg_time=(Adj_time_acc+Adj_time_cont)*.5

"Adjusted Power"

Adj_power=P_a/(3^(1/2))

"Adjusted Torque"

Adj_torque=T3/(3^(1/2))

SOLUTION

Unit Settings: SI C kPa kJ mass deg

$a = 5.563$ [m/s^2]
$Adj_{avg,time} = 31.64$ [min]
$Adj_{time,acc} = 12.79$ [min]
$Adj_{torque} = 589.5$ [lbf-in]
$Amps = 14.41$ [A]
$Avg = 18.27$ [min]
$Capacity = 7$ [A-hr]
$Cont_{amp} = 8.319$ [A]
$d = 0.3048$ [m]
$F_g = 0$ [N]
$F_w = 194.5$ [N]
$M = 136.1$ [kg]
$Power = 345.8$ [W]
$r = 0.1524$ [m]
$RPM = 113$ [1/min]
$R_m = 0.089$ [Ωs]
$T2 = 85.08$ [lbf-ft]
$\theta = 0$ [deg]
$Time_{cont} = 29.15$ [min]
$Acc_{amp} = 32.84$ [A]
$Adj_{power} = 1.057$ [Hp]
$Adj_{time,cont} = 50.49$ [min]
$Amphour = 56.88$ [A*hr]
$Amps_{acc} = 56.88$ [A]
$A_f = 2.352$ [m^2]
$Cd = 0.41$
$Cr = 0.1443$
$F_d = 1.829$ [N]
$F_r = 192.7$ [N]
$g = 9.81$ [m/s^2]
$Max_a = 105.3$ [A]
$P_a = 1.831$ [Hp]
$\rho = 1.2$ [kg/m^3]
$R_l = 0.025$ [Ωs]
$T = 115.4$ [n-m]
$T3 = 1021$ [lbf-in]
$Time_{acc} = 7.384$ [min]
$Torque = 93.75$ [lbf-in]

$Torque_{output}$ = 1167 [lbf-in]
$Torque_{output,lbf}$ = 97.27 [lbf-ft]
V = 1.778 [m/s]
z = 0.00635 [m]

No unit problems were detected.

KEY VARIABLES

P_a = 1.831 [Hp]	*A.) Power needed during acceleration*
T3 = 1021 [lbf-in]	*B.) Torque needed during acceleration*
Amps = 14.41 [A]	*C.) Continuous amperage needed at max speed*
$Amps_{acc}$ = 56.88 [A]	*D.) Amperage needed during acceleration*
$Torque_{output}$ = 1167 [lbf-in]	*E.) Torque output of motor*
Max_a = 105.3 [A]	*F.) Max amperage of battery*
$Time_{cont}$ = 29.15 [min]	*G.) Time of operation for continuous cycle*
$Time_{acc}$ = 7.384 [min]	*H.) Time of continuous acceleration*
Avg = 18.27 [min]	*I.) Average time of operation*
$Cont_{amp}$ = 8.319 [A]	*J.) Continuous amperage for each motor*
Acc_{amp} = 32.84 [A]	*K.) Amperage needed during acceleration for each motor*
$Adj_{time,cont}$ = 50.49 [min]	*L.) Continuous operating time per motor*
$Adj_{time,acc}$ = 12.79 [min]	*M.) Operating time for acceleration per motor*
$Adj_{avg,time}$ = 31.64 [min]	*N.) Average operating time per motor*
Adj_{power} = 1.057 [Hp]	*O.) Power needed per motor*
Adj_{torque} = 589.5 [lbf-in]	*P.) Torque needed per motor*